attain this end the relation between the water levels outside and inside the dam must be that shown in Fig. 1 by the full and dotted lines respectively. The motors or turbines must be designed to work efficiently with any head from 0 to H, and able to do all the work in such a short time that the high and low water levels remain practically constant during that interval, say 20 minutes.

If the interval between high and low water is six hours, the motors must be capable of delivering eighteen times the average power, and of this power 17/18 must be stored. It is, of course, impracticable to fulfil these conditions. The turbines have to work with a nearly constant head, and it would be impossible to arrange for the whole work to be done in the short time available at high and low water.

The most practicable plan is indicated in Fig. 2. The flow through the turbines is adjusted to reduce the rise and fall inside the dam to half that of the tide and the time of working increased to about three hours. The effective head is H/4, and the distance through which it acts (*i.e.* the stroke) is H/2. In this way about one-fourth of the tidal energy $\left(w.A\frac{H^2}{2}\right)$ might be utilised, half of which would have to be stored if the power supply is to be constant. Taking into account the various losses due to turbine, electrical, and storage efficiency, it is improbable that more than one-fifth of the whole tidal power could be delivered as electric current.

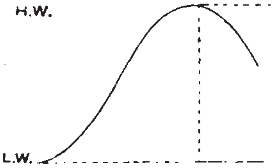

FIG. 1.

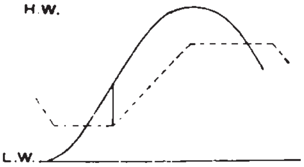

FIG. 2.

If A is 1 square mile and H 30 ft., it will be found that for each square mile of reservoir surface something more than 10,000 h.p. might be expected.

I have no knowledge of the details of the Severn scheme, but if it were possible—which I doubt—to enclose 20 square miles of estuary where the average difference of tidal level was 30 ft., the power available for distribution would be under 250,000 h.p.

It may be remarked that the same power could be obtained from a river having a current of little more than 2 miles per hour and a cross-sectional area of 2000 ft., if in its course there was a fall of 30 ft.

A. MALLOCK.

Heredity and Acquired Characters.

IN NATURE of January 6 there appears a long communication on heredity by Sir Archdall Reid which he conceives to be a reply to criticisms made on a former letter by him on the same subject by Sir Ray Lankester, Prof. Poulton, Dr. Gates, and myself. Leaving these eminent biologists to look after themselves, which they are quite capable of doing, perhaps you will allow me to say a word or two on some points raised in the letter in the current issue.

Sir Archdall Reid accuses me of torturing "a word which has now an established and perfectly clear meaning." The word is "variation." I wished to contribute to clearness by defining it, for, so far from its having a clear meaning, there are at least three senses in which it can be used. Further, let me say that if a five-fingered child were born of a six-fingered parent, I should not describe it as a "variation," but as a "reversion."

Next, Sir Archdall Reid challenges me to define the "quibble" about "acquired character." "Acquired character" is a technical term; by it is meant a quality, *i.e.* the degree of development of an organ, which is produced as a response to function, altered from the normal in response to an alteration of the environment from the normal; but Sir Archdall Reid interprets it as any adult character whatever.

Sir Archdall Reid has, however, understood the point, because he says that "the supposition that 'acquirements' tend to become 'innate' is . . . ridiculous." Such an *ex cathedra* statement contributes nothing useful to the discussion. There are definite experiments on record which, if true, prove this very point, but Sir Archdall Reid apparently knows nothing about them.

Then we are told that "low in the animal scale we find little or no evidence of development in response to functional activity." On reading this the question that instantly occurs to one's mind is: "Where did Sir Archdall Reid learn his zoology?" I have been working with Echinoderm larvæ for many years, and in no animals known to me is structure more sensitive to changes in the environment (Proc. Roy. Soc., B, vol. xc., 1918).

Lastly, Sir Archdall Reid says: "We are now in the morass in which Lamarck and Weismann floundered." I have attended many congresses of biologists, and I have never found evidence of confusion in their minds as to what was meant by an "acquired character." They differed, and continue to differ, as to whether there is evidence that an "acquired character" can be inherited, or, to use Sir Archdall Reid's paraphrase, that "acquirements" can become "innate," and this difference can be settled only by the outcome of experiments which are now in progress, but I have nowhere detected evidence of a condition of thought that could be described as a "morass." I conclude, therefore, that it exists alone in Sir Archdall Reid's mind. E. W. MACBRIDE.

Imperial College of Science and Technology,
South Kensington, S.W.7, January 7.

PROVIDED that biologists understand one another, it is, perhaps, not an insuperable barrier to the progress of biology that Sir Archdall Reid is unable to understand their terminology. I write merely to point out that though he seeks to teach biologists the proper use of terms, Sir Archdall Reid, in his letter in NATURE of January 6, contradicts himself in his own terminology. He states that even in human beings many characters do not develop in the least in response to functional activity, *e.g.* hair and external generative organs. On the other hand, in man most characters develop wholly, or almost wholly, in response to that stimulus. Yet in another paragraph he asserts that all characters are necessarily innate, acquired, germinal, somatic, and inheritable in *exactly the same sense and degree.* If biologists recognise, as Sir Archdall Reid does, a difference between characters that develop in response to functional activity and those which do not, what need is there for him to ask biologists why they describe some characters as "innate," "germinal," and "inheritable," and others as "acquired," "somatic," and "non-inheritable"? J. T. CUNNINGHAM.

University of London Club, 21 Gower
Street, W.C.1, January 7.

Solar Radiation in Relation to the Position of Spots and Faculæ.

ABOUT September 1 last an arrangement was made between the Director of the Argentine Meteorological Service and the Director of the Astronomical Observatory of the University of La Plata for observations of

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disturbances visible on the surface of the sun, including spots and faculæ to be recorded on a diagram of the sun's surface and transmitted to the Meteorological Office for the purpose of comparing them with the observations of solar radiation received from the Smithsonian Solar Observatory at Calama, Chile.

The observations at first consisted chiefly of a record of sun-spots, and although the time is short the relation seems so apparent as to be worthy of record. The records have been arranged in three series, two of which are practically independent of each other and the third partly so.

The first series was derived from seven groups of sun-spots by taking the day of their first appearance on the east edge of the sun three days before and five days after, and obtaining the average values observed of solar radiation on these days in calories per square centimetre.

The second series was derived from six groups of sun-spots by taking out the mean solar radiation on the last day of visibility and for five days preceding and three days following.

The third series was derived from seven series of spots by taking the mean solar values on the days the spots crossed the solar meridian and for eight days preceding and eight days following.

The results are shown in the following table:

Mean Radiation Values for Different Positions of Sun-spots.

(1)	Days before.		East edge.	First seen.	Days after.				
	2	1	0	1	2	3	4	5	6
Radiation	40	24	45	55	52	48	37	47	39

(2)	Days before.					Last seen.	West edge.	Days after.	
	6	5	4	3	2	1	0	1	2
Radiation	46	45	35	30	48	50	54	40	38

(3) Days before.								Meridian	Days after.							
8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8
42	38	40	49	41	48	33	46	44	45	35	47	40	49	46	40	38

The mean solar radiation value is formed by adding 1·900 to the values given in the table.

As the spots are rarely seen exactly on the edge of the sun, the day on which they are first seen is numbered 1, and the day before is numbered 0; also, when last seen the day is numbered 1, and the day after 0.

The mean solar values during the interval covered by the observations is 1·943, so that on the day when the spots were first seen the radiation averaged 0·012 calorie above normal, and when last seen 0·007 calorie above, or in the mean about ½ per cent. of the solar radiation.

There was one day common to the two series when spots were visible on both edges of the sun at the ends of a diameter passing through the sun's centre, or, in other words, on a great circle about 180° apart. On this day the solar radiation value was 1·969, or more than 1 per cent. above normal.

The grouping around the central passage of the spots does not bring out the relation so distinctly, although higher values are found five days before and five days after the passage across the meridian, the lowest values being found two days before and two days after the central position. If one takes the mean of the five days about the centre, including two days before and two days after the central passage, a value of 1·941 is obtained, which is slightly below the normal value, as if some absorption of heat resulted from the central passage of the spots.

These results have an interest in connection with the fact that Dr. Abbot found a decrease in the contrast of brightness between the edge and centre of the sun coinciding with short-period increase of solar radiation (Smithsonian Miscellaneous Collections, vol. lxvi., No. 5). Both these results can, I think, be explained in the same way. It is well known that solar faculæ and solar eruptions surround regions where spots are numerous.

These eruptions when seen near the edge of the sun tend to decrease solar contrast and to increase the total solar radiation. On the other hand, when they are near the centre of the sun they are seen directly above the hotter gases from which radiation is coming vertically through the sun's atmosphere, and hence is not greatly absorbed.

The cooler gases within the spots may even absorb more of this radiation than is made up for by the increased radiation of the faculæ in the outer atmosphere.

The results, if confirmed by more extended observations, will also have an important meteorological bearing. Numerous investigators like Loomis, Veeder, Arctowski, and Huntington have found evidences of increased solar influences on the earth's atmosphere when the solar spots were near the edge of the sun. E. Huntington especially has made an extensive investigation of the position of the solar spots as related to the storminess in the North Atlantic, and has found that the most marked effects are shown when the spots are near the edge of the sun, and hence when there is probably increased solar radiation (Monthly Weather Review, U.S.A. Weather Bureau, March–June, 1918). H. H. CLAYTON.

Buenos Aires, November 6.

Odours Caused by Attrition.

THE unpleasant odour which attends the attrition of pebbles, etc., appears to have been noticed at a much earlier date than any mentioned by previous correspondents. Robert Boyle ("The Efficacy of Languid Motion," Works, edited by Boulton, 1699, vol. i., p. 234) remarks: "And that it may further appear, that a peculiar Modification of Motion, may contribute to the various Effects produced by it, I shall observe, That those Stones which *Italian* Glass-men make use of [quartz?], afford Sparks of Fire by Collision; but if moderately rubb'd together, they emit *fœtid* Exhalations; from whence probably proceed those offensive Steams, emitted by Glass; and what is more remarkable, and to our purpose is, tho' Glass when Red-hot emits no such *Effluvia*; yet if two pieces be dextrously rubb'd together, they will send forth Steams copious enough and *fœtid*."

It seems to me that there are at least two suggestions not brought forward by previous correspondents in NATURE contained in Boyle's observations, both of which might well be followed up experimentally. The implicit explanation of the cause of smell is also of some interest. J. R. PARTINGTON.

Lostock Gralam, Cheshire.

The Energy of Cyclones.

I SHALL be glad if you will allow me to refer briefly to the objection Mr. W. H. Dines raises to my theory of cyclones (NATURE, December 23, p. 534). Mr. Dines remarks that if "cyclones are caused by an access of warmth in the stratosphere . . . the troposphere ought to bulge upwards over the cyclone, whereas, in fact, it bulges downwards." My view is that where the stratosphere is warmest it must be thickest, and the troposphere must be thin. As the warmest portions of the stratosphere are at cyclonic centres, the lower boundary of the stratosphere must bulge downwards over such areas and the troposphere be correspondingly thin. I assume that the heat of the stratosphere passes downwards so rapidly that the slowly rising air cannot maintain the troposphere at its normal thickness. R. M. DEELEY.

Tintagil, Kew Gardens Road, Kew, Surrey,
December 24.

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